

Nephron

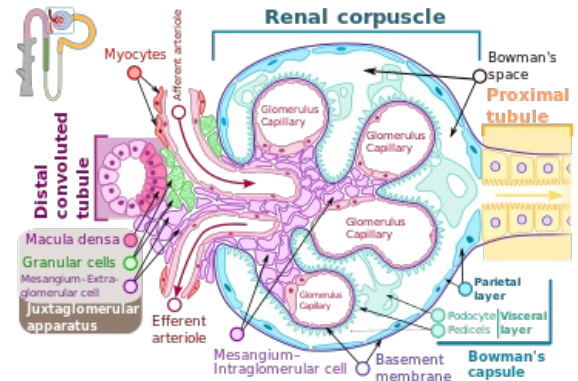
The nephron is the basic functional and microscopic unit of the kidney. Each kidney contains about one million of them.

Structure and Function

A nephron consists of a renal corpuscle and a renal tubule:

Renal corpuscles consist of a

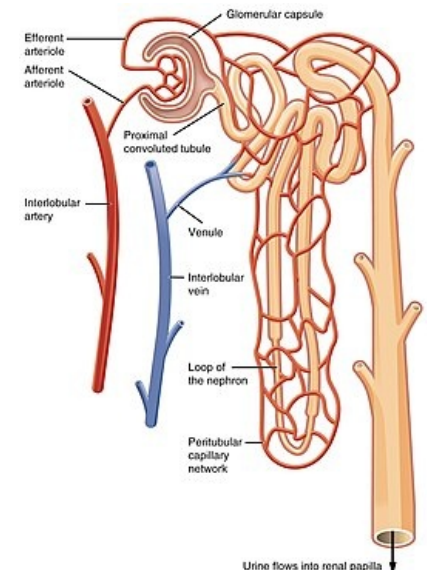
- **glomerulus**
 - consists of an anastomosing capillary network
 - afferent arteriole brings blood in
 - capillaries covered by podocytes with pedicles to create filtration slits
 - efferent arterioles drain blood into peritubular capillaries. These surround the nephrons; water and solutes get reabsorbed back into them, some solutes are secreted out of them
 - mesangial cells (between arteries) influence filtration rate, ability to contract to decrease filtration area
 - protein passage barrier
 - negatively charged layers of glomerular membrane allows cationic molecules to pass through more easily
- **Bowman's capsule**
 - Formed by a visceral and parietal layer
 - Encapsulates glomerulus
 - *Bowman's space* is in between the glomerulus and Bowman's capsule
 - Blood is filtered from arteries into Bowman's space
 - Epithelial cells function in absorption and secretion



Renal corpuscle

A **renal tubule** is continuous with Bowman's capsule and can be divided into several sections along its course. The epithelial cells have a different ultrastructure along the different sections.

- proximal convoluted tubule
 - extensive brush border
- proximal straight tubule
- Loop of Henle
 - thin descending limb
 - thin ascending limb
 - thick ascending limb
- distal convoluted tubule
 - touches the glomerulus at the **macula densa**
- connecting tubule: distal tubule's final part, connects to the collecting duct



Nephron

Absorption surface area decreases going from the PCT toward the DCT because of a decreasing amount of microvilli.

Functional histology

Glomerulus consists of **fenestrated capillaries without diaphragm** that form important part of a renal filtration barrier. Blood flow and blood pressure in afferent and efferent arteriole is strictly regulated, which allows glomerular filtration into Bowman's capsule. Visceral layer of Bowman's capsule consists of **podocytes** and their **pedicels** that tightly fit to the basement membrane of capillaries. Parietal layer is formed by a single layer of simple squamous epithelium. The **renal filtration barrier** is composed of the **fenestrated capillary endothelium**, the **basement membrane** and the **pedicles of podocytes**. Pedicels interdigitate with one another forming filtration slits that are spanned by **slit diaphragms** (formed by protein **nephrin**). Due to its negative charge it prevents the filtration of plasma proteins.

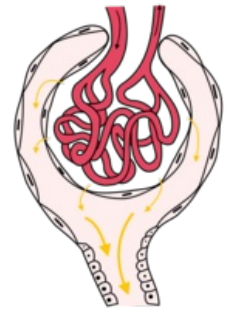
In the glomerulus we can find **mesangium** that provides mechanical support, has the phagocytic activity and secretes prostaglandins. **Mesangial cells** outside the glomerulus together with the **macula densa cells** (distal segment of the ascending limb of loop of Henle) and the **granular cells** (modified smooth muscle cells of the afferent arteriole) from **juxtaglomerular apparatus**. This is the place where renal corpuscle gets into contact with the renal tubular system.

The proximal tubule is lined by simple cuboidal epithelium with a well-developed brush border on the luminal side, the thin portion of Henle's loop is lined by a simple squamous epithelium (poor in organelles). The distal tubule cells are smaller than those of proximal tubule and lack the brush border. Collecting ducts consist of principal intercalated cells.

Types

There are two types of nephrons:

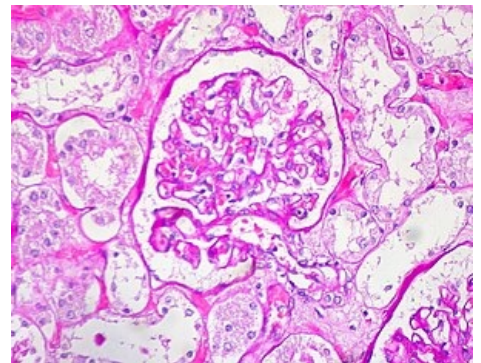
- **cortical nephrons**
 - glomeruli are in outer cortex
 - relatively short loops of Henle, reaching only the outer medulla
 - only function in blood filtration
 - tubular system surrounded by peritubular capillary network
- **juxtamedullary nephrons**
 - glomeruli near corticomedullary border
 - glomeruli are larger and have higher Glomerular Filtration Rate (GFR)
 - long loops of Henle descend deep into inner medulla and papillae
 - serve for counter-current multiplication, resulting in a salty medulla
 - efferent arterioles extend from glomeruli into outer medulla
 - vasa recta extend downward into medulla next to loops of Henle
 - cortical veins return blood



Structure of glomerulus

References

- Costanzo, Linda. *Physiology*. 6th ed., Elsevier, 2018, pp. 245-246.
- Dušíková, Kristýna et al. "3. Urine Formation • Functions Of Cells And Human Body". *Fblt.Cz*, <http://fblt.cz/en/skripta/vii-vylucovaci-soustava-a-acidobazicka-rovnovaha/3-tvorba-moci/>.



Glomerulus